11.34 Use algebraic manipulations to simplify the following:

$\overline{\ldots \overline{A}B) + (A + \overline{B})}$

11.35 Use algebraic manipulations to show that the exclusive-NOR operation has the equivalent forms

$A \odot B = (A + \overline{B})(\overline{A} + B) = AB + \overline{A}\,\overline{B}$

11.36 Use algebraic manipulations to show that the exclusive-OR operation has the equivalent forms

$A \oplus B = A\overline{B} + \overline{A}B = (A + B)(\overline{AB})$

11.37 Use algebraic manipulations to show that

$\ldots + \overline{A}\overline{C} = (\overline{A} + B)(A + \overline{C})$

11.38 Find the dual of the expression given in (a) Problem 11.33, (b) Problem 11.34, (c) Problem 11.35, (d) Problem 11.36, and (e) Problem 11.37.

11.39 Use algebraic manipulations to show that the exclusive-OR operation $A \oplus B = A\overline{B} + \overline{A}B$ is (a) commutative, that is, $A \oplus B = B \oplus A$; (b) associative, that is, $A \oplus (B \oplus C) = (A \oplus B) \oplus C$.

11.40 Use algebraic manipulations to show that the exclusive-NOR operation $A \odot B = AB + \overline{A}\,\overline{B}$ is (a) commutative, that is, $A \odot B = B \odot A$; and (b) associative, that is, $A \odot (B \odot C) = (A \odot B) \odot C$.

11.41 Show that (a) $A \uparrow B = B \uparrow A$, and (b) $A \uparrow (B \uparrow C) \neq (A \uparrow B) \uparrow C$, where $\uparrow$ denotes the NAND operation.

11.42 Construct a truth table for the function $F_1 = A \uparrow (B \uparrow C)$, where $\uparrow$ denotes the NAND operation. Express F_1 as (a) a sum of minterms, and (b) a product of maxterms. Repeat for $F_2 = (A \uparrow B) \uparrow C$.

11.43 Realize an exclusive-OR gate using only (a) NAND gates, and (b) NOR gates. Repeat for an exclusive-NOR gate.

11.44 A **majority gate** is a logic circuit whose output is 1 when a majority (more than half) of its inputs are 1. Construct the truth table for a three-input majority logic gate. Express the Boolean function F that describes the output of the gate as (a) a sum of minterms, and (b) a product of maxterms. Realize both of these expressions using AND gates and OR gates.

11.45 Show that the Boolean function $F = AB + BC + AC$ describes the output of a three-input majority gate (see Problem 11.44) by constructing the corresponding truth table. Implement this function with a two-level logic circuit employing only NAND gates.

11.46 Show that the Boolean function $F = (A + B)(B + C)(A + C)$ describes the output of a three-input majority gate (see Problem 11.44) by constructing the corresponding truth table. Implement this function with a two-level logic circuit employing only NOR gates.

11.47 Express the Boolean function $F = A + BC$ as (a) a sum of minterms, and (b) a product of maxterms. Realize the expression obtained in part (a), the expression obtained in part (b), and the expression $F = A + BC$ by using AND gates and OR gates. Which realization requires the fewest logic gates?

11.48 Implement the Boolean function $F = A + BC = (A + B)(A + C)$ with a two-level logic circuit employing only (a) NAND gates, and (b) NOR gates.

11.49 Use algebraic manipulations to express the Boolean function $F = AB + BC + AC$ as (a) a sum of minterms, and (b) a product of maxterms.

11.50 Use algebraic manipulations to express the Boolean function $F = \overline{A}\,\overline{B} + B\overline{C}$ as (a) a sum of minterms, and (b) a product of maxterms.

11.51 Find the simplified sum-of-products form of the Boolean functions: (a) $\overline{A}\,\overline{B}C + \overline{A}B\overline{C} + A\overline{B}\,\overline{C} + ABC$, (b) $\overline{A}\,\overline{B}\,\overline{C} + \overline{A}\,\overline{B}C + \overline{A}B\overline{C} + A\overline{B}C + ABC$, (c) $\overline{A}BC + A\overline{B}C + AB\overline{C} + ABC$, and (d) $\overline{A}\,\overline{B}\,\overline{C} + \overline{A}\,\overline{B}C + \overline{A}B\overline{C} + AB\overline{C}$.

11.52 Find the simplified product-of-sums forms of the Boolean functions given in Problem 11.51.

11.53 Find the simplified sum-of-products forms of the Boolean functions that correspond to the Karnaugh maps shown in Fig. P11.53.

(a)

A \ BC	00	01	11	10
0		1	1	1
1	1	1		

(b)

A \ BC	00	01	11	10
0				1
1	1		1	1

(c)

A \ BC	00	01	11	10
0	1	1	1	1
1		1		1

Fig. P11.53

11.54 Find the simplified product-of-sums forms of the Boolean functions corresponding to the Karnaugh maps given in Fig. P11.53.

11.55 Find the simplified product-of-sums form of the Boolean functions:

(a) $(A + B + C)(A + B + \overline{C})(A + \overline{B} + \overline{C})(\overline{A} + B + \overline{C})(\overline{A} + \overline{B} + \overline{C})$

(b) $(A + B + \overline{C})(A + \overline{B} + \overline{C})(A + \overline{B} + C)$

(c) $(A + B + \overline{C})(\overline{A} + B + \overline{C})(\overline{A} + \overline{B} + C)(\overline{A} + \overline{B} + \overline{C})$

11.56 Find the simplified sum-of-products forms of the Boolean functions given in Problem 11.55.

11.57 Find the simplified sum-of-products forms of the Boolean functions that correspond to the Karnaugh maps shown in Fig. P11.57.

11.58 Find the simplified product-of-sums forms of the Boolean functions corresponding to the Karnaugh maps given in Fig. P11.57.

11.59 Find the simplified sum-of-products forms of the Boolean functions (a) $\overline{A}(\overline{B} + \overline{C}) + \overline{A}B +$ [illegible] (b) $A(B + \overline{D}) + \overline{B}(C + AD)$, and (c) $\overline{B}D +$ [illegible] $A(\overline{B}C + B\overline{C})$.

(a)

AB \ CD	00	01	11	10
00				
01	1	1	1	1
11		1	1	1
10				1

(b)

AB \ CD	00	01	11	10
00		1	1	1
01				1
11		1		1
10		1	1	1

(c)

AB \ CD	00	01	11	10
00	1		1	
01			1	1
11		1		1
10	1			1

Fig. P11.57